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(54) HOT-DIP GALVANIZED STEEL SHEET SUPERIOR IN FORMABILITY

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a hot-dip galvanized steel sheet superior in formability, without needing a facility for generating oxide or forming a film.

SOLUTION: The hot-dip galvanized steel sheet superior in formability, which has a galvanizing layer including 0.05-10 wt.% Al, and 0.01-5 wt.% Mg if required, further 0.01-2 wt.% Si, and the balance Zn with unavoidable impurities, is characterized in that the surface of the galvanized steel sheet has a center line average roughness Ra of 0.5-1.5 μm, PPI (a number of peaks of 1.27 μm or higher included in 1 inch (2.54 cm)) of 150-300, and Pc (a number of peaks of 0.5 μm or higher included in 1 cm) of PPI/2.54+10 or more.

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ABSTRACT:

PROBLEM TO BE SOLVED: To provide a hot-dip galvanized steel sheet superior in formability, without needing a facility for generating oxide or forming a film.

SOLUTION: The hot-dip galvanized steel sheet superior in formability, which has a galvanizing layer including 0.05-10 wt.% Al, and 0.01-5 wt.% Mg if required, further 0.01-2 wt.% Si, and the balance Zn with unavoidable impurities, is characterized in that the surface of the galvanized steel sheet has a center line average **roughness Ra** of 0.5-1.5 μm, **PPI** (a number of peaks of 1.27 μm or higher included in 1 inch (2.54 cm)) of 150-300, and Pc (a number of peaks of 0.5 μm or higher included in 1 cm) of **PPI**/2.54+10 or more.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which aluminum:0.05 - 10 mass % is contained and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
[Claim 2] In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which 0.05 to aluminum:10 mass % and Mg:0.01 - 5 mass % are contained, and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
[Claim 3] In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which four to aluminum:20 mass %, two to Mg:10 mass %, and Si:0.01 - 2 mass % are contained, and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
[Claim 4] The hot-dip zinc-coated carbon steel sheet excellent in the moldability of any one publication of claim 1-3 characterized by the X diffraction intensity ratio of the Miller-indices (002) side of Zn crystal of a plating layer and a field (101) being two or more.
[Claim 5] the content of the alloying element in steel -- mass % -- C: 0.0001 - 0.004%, Si:0.001-0.10%, Mn:0.01-0.50%, and P: 0.001 - 0.015%, and S: 0.015% or less, aluminum:0.005-0.10%, Ti:0.002-0.10%, and N: Hot-dip zinc-coated carbon steel sheet excellent in the moldability of any one publication of claim 1-4 characterized by containing 0.0005 - 0.004% and consisting of the remainder Fe and an unescapable impurity.
[Claim 6] The hot-dip zinc-coated carbon steel sheet the steel plate excelled [hot-dip zinc-coated carbon steel sheet] in the moldability according to claim 5 characterized by containing Nb:0.002-0.10% by mass % further as an addition component.
[Claim 7] The hot-dip zinc-coated carbon steel sheet excellent in the moldability according to claim 5 to which Ti content in steel is characterized by satisfying the conditions given by following the (1) formula (content of the alloy element X which expressed [%X] with mass %).
[Equation 1]
$$[\%Ti] \geqq 4[\%C] + 3.4[\%N] + 1.5[\%S] \cdots (1)$$

[Claim 8] The hot-dip zinc-coated carbon steel sheet excellent in the moldability according to claim 6 to which the content in [Ti and Nb] steel is characterized by satisfying the conditions given by following the (2) - (3) formula (content of the alloy element X which expressed [%X] with mass %).
[Equation 2]
$$([\%Ti]+0.52[\%Nb]) \geq 4[\%C]+3.4[\%N]+1.5[\%S] \quad \cdots (2)$$

$$[\%Ti] \geq 0.009\% \quad \cdots (3)$$

[Claim 9] The hot-dip zinc-coated carbon steel sheet of any one publication of claim 5-8 with which a steel plate is further characterized by containing B:0.0002 - 0.003% by mass % as an addition component.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention has the outstanding moldability in more detail with respect to a hot-dip zinc-coated carbon steel sheet, and relates to a plating steel plate applicable as a steel plate for automobiles, various the application for building materials, for example, object.
[0002]
[Description of the Prior Art] There is a hot-dip zinc-coated carbon steel sheet as a corrosion resistance good plating steel plate. Usually the preheating of this hot-dip zinc-coated carbon steel sheet is carried out in a clean heating furnace after degreasing a steel plate, it performs reduction annealing with a reducing furnace for surface defecation and quality-of-the-material reservation, and is manufactured by being immersed in a melting zinc bath and carrying out coating weight control. As the description, since it excels in corrosion resistance, plating adhesion, etc., the automobile, the building-materials application, etc. are widely used as a core.
[0003] Compared with an alloying hot-dip zinc-coated carbon steel sheet, since plating is soft, . as which the outstanding moldability is especially required in the case of the steel plate for automobiles since it is included in an automobile in response to complicated fabrication, and a hot-dip zinc-coated carbon steel sheet need to raise sliding nature that it is easy to gnaw with metal mold.
[0004] As a technique which raises the sliding nature of a hot-dip zinc-coated carbon steel sheet Like the technique and JP,3-249180,A which make a front face generate the oxide of 20 which makes ZnO a subject - 3000 mg/m2 like JP,4-325665,A, on a zinc system plating steel plate front face Mn oxide of the amount of specification, A phosphoric acid, Mo oxide, etc. of the amount of specification The technique which covers the coat to contain, the technique of making the covering constituent containing the compound which has a lubrication action like JP,9-111473,A forming, the technique of making a phosphorylation object system inorganic coat forming like JP,2000-256874,A, etc. are mentioned.
[0005]
[Problem(s) to be Solved by the Invention] However, with the above-mentioned technique, since an oxide is made to generate or the facility in which a coat is made to form is needed, when the tooth space does not exist, it cannot adopt. Moreover, the problem on which a production cost goes up by such facility installation is also produced. Then, this invention solves the above-mentioned trouble and offers the hot-dip zinc-coated carbon steel sheet excellent in the moldability, and its manufacture approach.
[0006]
[Means for Solving the Problem] As a result of repeating research wholeheartedly about the hot-dip zinc-coated carbon steel sheet excellent in the moldability, by controlling the roughness of a plating steel plate front face, this invention persons found out that the moldability of a hot-dip zinc-coated carbon steel sheet could be raised, and made this invention. Moreover, when the stacking tendency of the specific field of Zn crystal of a plating layer was strong, it found out raising a moldability further and this invention was made.
[0007] That is, the place made into the summary of this invention is as follows.

(1) In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which aluminum:0.05 - 10 mass % is contained and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
(2) In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which 0.05 to aluminum:10 mass % and Mg:0.01 - 5 mass % are contained, and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
(3) In the hot-dip zinc-coated carbon steel sheet which has the galvanization layer which four to aluminum:20 mass %, two to Mg:10 mass %, and Si:0.01 - 2 mass % are contained, and the remainder becomes from Zn and an unescapable impurity Center line average-of-roughness-height Ra of this plating steel plate front face 0.5-1.5 micrometers, PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)]) that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 The hot-dip zinc-coated carbon steel sheet excellent in the moldability by which it is characterized.
(4) plating -- a layer -- Zn -- a crystal -- Miller indices (002) -- a field -- a field (101) -- an X diffraction -- an intensity ratio -- two -- more than -- it is -- things -- the description -- ** -- carrying out -- the above -- (-- one --) - (-- three --) -- a publication -- a moldability -- having excelled -- a hot-dip zinc-coated carbon steel sheet .
(5) the content of the alloying element in steel -- mass % -- C: -- 0.0001 - 0.004%, Si:0.001-0.10%, Mn:0.01-0.50%, and P: 0.001 - 0.015%, and S: 0.015% or less, aluminum:0.005-0.10%, Ti:0.002-0.10%, and N: The hot-dip zinc-coated carbon steel sheet excellent in the moldability given in aforementioned [which is characterized by containing 0.0005 - 0.004% and consisting of the remainder Fe and an unescapable impurity] (1) - (4).
(6) The hot-dip zinc-coated carbon steel sheet the steel plate excelled [hot-dip zinc-coated carbon steel sheet] in the moldability given in the above (5) with which it is characterized by containing Nb:0.002-0.10% by mass % further as an addition component.
(7) The hot-dip zinc-coated carbon steel sheet excellent in the moldability given in the above (5) whose Ti content in steel is characterized by satisfying the conditions given by following the (1) formula (content of the alloy element X which expressed [%X] with mass %).
[Equation 3]
[%Ti] ≧4[%C] +3. 4[%N] +1. 5[%S]… (1)

(8) The hot-dip zinc-coated carbon steel sheet excellent in the moldability given in the above (6) whose content in [Ti and Nb] steel is characterized by satisfying the conditions given by following the (2) - (3) formula (content of the alloy element X which expressed [%X] with mass %).
[Equation 4]
([%Ti] +0. 52[%Nb]) ≧4[%C] +3. 4[%N] +

1. 5[%S] … (2)

[%Ti] ≧0. 009% … (3)

(9) A hot-dip zinc-coated carbon steel sheet given in aforementioned (5) - (8) to which a steel plate is further characterized by containing B:0.0002 - 0.003% by mass % as an addition component.

[0008]
[Embodiment of the Invention] This invention is explained below at a detail. In this invention, what gave the Zn-aluminum plating layer on the steel plate, the thing which gave the Zn-aluminum-Mg plating layer, and a Zn-aluminum-Mg-Si plating layer are given with a hot-dip zinc-coated carbon steel sheet.
[0009] The reason which limited aluminum presentation of a Zn-aluminum plating layer and a Zn-aluminum-Mg plating layer to 0.05 - 10 mass % in this invention is for a Zn-Fe alloying reaction to occur at the time of plating processing, for an alloy layer weak against a ferrite interface to progress, if the hot-dipping processing usual in the amount of aluminum of under 0.05 mass % is performed, and for plating adhesion to deteriorate, and when 10 mass % is exceeded, it is for growth of a Fe-aluminum alloy layer becoming remarkable, and preventing plating adhesion.
[0010] Under in 0.01 mass %, the reason which limited Mg presentation of a Zn-aluminum-Mg plating layer to 0.01 - 5 mass % is because the effectiveness of improving corrosion resistance is not seen, and when 5 mass % is exceeded, it is because dross occurs so much and manufacture becomes difficult during a plating bath.
[0011] Moreover, in this invention, it becomes possible by the melting zinc plating bath of a high aluminum quantity Mg presentation to dissolve Si at low temperature. If Si is added to this melting zinc plating bath, in order to control growth of a Fe-aluminum alloy layer, if the addition of aluminum is made to increase to . pan that whose the addition of aluminum is made to increase it becomes possible, dross generating under plating bath by addition of Mg can be controlled, and it becomes possible to make the addition of Mg increase.
[0012] The reason which limited aluminum presentation of a Zn-aluminum-Mg-Si plating layer to 4 - 20 mass % in this invention is because the effectiveness which controls dross generating under plating bath by addition of Mg is not seen while the effectiveness of dissolving Si during a plating bath is not seen in the amount of aluminum of under 4 mass %, and when 20 mass % is exceeded, it is because the melting point of a plating bath rises and manufacture becomes difficult.
[0013] Under in 2 mass %, the reason which limited Mg presentation to 2 - 10 mass % is because the effectiveness of dissolving Si during a plating bath is not seen, and when 10 mass % is exceeded, it is because dross occurs so much and manufacture becomes difficult during a plating bath.
[0014] Under in 0.01 mass %, the reason which limited Si presentation to 0.01 - 2 mass % is because the effectiveness which controls growth of a Fe-aluminum alloy layer is not seen, and when 2 mass % is exceeded, it is because the melting point of a plating bath rises and manufacture becomes difficult.
[0015] Furthermore, even if Fe, nickel, Sb, Pb, Sn, and Cu are included as additional trace elements usually used during the plating bath, there is especially no effect in the effectiveness of this invention. Although especially constraint is not prepared about plating coating weight, either, it is a corrosion resistance viewpoint to one side 10 g/m2. It is one side 150 g/m2 above, considering the viewpoint of workability. It is desirable that it is the following. In addition, as a steel plate of a substrate, although hot rolled sheet steel and cold rolled sheet steel can be used, the steel plate of the super-low carbon system which added Ti, Nb, B, etc. which are mentioned especially later is excellent in workability, and desirable.
[0016] In this invention, there is especially no place limited about the manufacture approach of a plating steel plate, and it can apply the hot-dipping method of the usual clean-heating-furnace method.
[0017] As for the roughness of a plating steel plate front face, it is desirable that 150-300, and Pc (the number of peaks with a magnitude of 0.5 micrometers or more contained in per cm) are Pc>=PPI / 2.54+10 in 0.5-1.5 micrometers and PPI (the number of peaks with a magnitude of 1.27 micrometers or more contained in per [1 inch (2.54cm)], SAE, J911 specification) at center line average-of-roughness-height Ra (B JIS 0601 specification). After preparing fixed reference level H in positive/negative and both directions and exceeding negative reference level from the average line of a granularity curve, the time of exceeding forward reference level is considered as one count, and it is displayed as the number of peaks here with the number which counted this count repeatedly until it reached the evaluation die length Ln. PPI set width-of-face 2H between reference level to 1.27 micrometers, and measured

evaluation die length as 1 inch (2.54cm). Pc set width-of-face 2H between reference level to 0.5 micrometers, and measured evaluation die length as 1cm.
[0018] In Ra, it is for die galling to tend to happen to the sliding surface at the time of shaping, and for lubricity to fall in less than 0.5 micrometers, less than 150 PPI, and less than 70 Pc, and in order to give the roughness which exceeds 1.5 micrometers and PPI300 by Ra, the bottom of high pressure is required for the reason which limited Ra to 0.5-1.5 micrometers, and limited PPI to 150-300, and Pc>=PPI / 2.54+10 in this invention, and it is for leading to deterioration of the quality of the material It is 200 or more in 0.7 micrometers or more and PPI preferably at Ra. moreover, although the reason sliding nature of the reason limited to Pc>=PPI / 2.54+10 improves by .Pc>=PPI which is because Pc<PPI / 2.54+10 is not enough as improvement in sliding nature / 2.54+10 is not clear, it ****s [****] with just deep irregularity being inadequate on a sliding disposition, and lubricating oil holdout being raised by making deep irregularity and the irregularity of whenever [middle] balance to some extent . . with very important since, as for hot dip zincing, there is almost no irregularity immediately after plating unlike the alloying hot dip zincing over which irregularity is distributed in the suitable depth from the first at the time of plating production, in case roughness is given making this deep irregularity and the irregularity of whenever [middle] balance to some extent -- it is Pc>=PPI / 2.54+20 preferably.
[0019] The surface roughness of the above-mentioned plating steel plate is controllable by the roll roughness of skin pass rolling after plating, skin pass rolling rolling reduction, etc. However, if skin pass rolling with big roughness is used for the purpose of high Ra and high PPI, since the front face of plating will serve as only deep irregularity and the irregularity of whenever [important on sliding disposition middle] will no longer be obtained, In order to obtain the above-mentioned roughness, it is necessary to use deep irregularity and the irregularity of whenever [middle] combining the roll of deep irregularity, and the roll of the irregularity of whenever [middle], using the roll made to balance moderately, and to obtain the target roughness.
[0020] In this invention, in order to raise sliding nature further, it is effective to make the X diffraction intensity ratio of the Miller-indices (002) side of Zn crystal of a plating layer and a field (101) or more into two. It is thought that its sliding nature on the front face of plating improves by raising the stacking tendency of a field (002) since a Miller-indices (002) side is a field where a consistency is the highest in Zn crystal lattice. Although less than two are not enough as the X diffraction intensity ratio of the Miller-indices (002) side of Zn crystal of a plating layer, and a field (101) as for this sliding disposition top effectiveness, improvement in sliding nature with this X diffraction intensity ratio clear at two or more is accepted.
[0021] Although a moldability can be raised by being able to use hot rolled sheet steel and cold rolled sheet steel, being able to improve lubricity by giving the roughness of this invention to plating also in which steel plate as a steel plate of a substrate, and making a plating layer with the still stronger stacking tendency of the specific field of Zn crystal form, the effectiveness is remarkable when the plating layer of this invention is given to the steel plate of the super-low carbon system which was excellent in especially deep drawability. Generally, although the deep drawability of cold rolled sheet steel is so good that an r value is large, in a plating steel plate, the effect of an r value is not so remarkable as cold rolled sheet steel. This is because the effect of lubricative on the front face of plating given to deep drawability is larger than the effect of an r value, and becomes possible [pulling out the engine performance which a steel plate originally has] by raising the lubricity on the front face of plating.
[0022] In this invention, the content of the alloying element in steel of the steel plate of a super-low carbon system is mass %. C: 0.0001 - 0.004%, Si:0.001-0.10%, Mn:0.01-0.50%, and P: 0.001 - 0.015%, and S: 0.015% or less, aluminum:0.005-0.10%, Ti:0.002-0.10%, and N: It is the thing of the steel plate which added B:0.0002 - 0.003% further to the steel plates which added Nb:0.002-0.10% further to the steel plate which contains 0.0005 - 0.004% and consists of the remainder Fe and an unescapable impurity, and the above-mentioned steel plate, and these steel plates.
[0023] Next, in this invention, the reason which limited the numeric value of C, Si, Mn, P, S, aluminum, Ti, N, Nb, and B is shown below. In addition, each % shown below expresses mass %.
[0024] Although C is an element which raises the reinforcement of steel and it is effective to make

0.0001% or more contain, since reinforcement will rise too much and workability will fall if contained superfluously, an upper limit content is made into 0.004%. When you need high workability especially, considering as 0.003% or less is desirable, and especially when C content is made into 0.002% or less, it is desirable.

[0025] Although Si is also the element which raises the reinforcement of steel and makes 0.001% or more contain, since workability and hot-dip-zincing nature will be spoiled if contained superfluously, an upper limit is made into 0.10%. When you need high workability especially, it makes Si content into 0.05% or less.

[0026] Since it is the element in which workability is reduced while Mn also raises the reinforcement of steel, an upper limit content is made into 0.50%. Although workability is so good that there is little Mn, since refinement cost becomes great in order to consider as less than 0.01%, a minimum content is made into 0.01%. As for Mn content, from the balance of reinforcement, workability, and cost, considering as 0.05 - 0.30% is more desirable.

[0027] Since it is the element in which workability is reduced while P also raises the reinforcement of steel, an upper limit content is made into 0.015%. Since refinement cost will become great on the other hand in order [being more desirable] to reduce P content to less than 0.001% if [workability is so good that there is little P, and] 0.010% or less, a minimum content is made into 0.001%. As for P content, from the balance of reinforcement, workability, and cost, considering as 0.003 - 0.010% is more desirable.

[0028] It is so desirable that there is S since it is an element in which the hot-working nature of steel and corrosion resistance are reduced, and an upper limit content is made into 0.015%, and is more preferably made into 0.010% or less. [little] However, what is necessary is not to reduce S too much and just to reduce S from a viewpoint of workability and plating adhesion, even from hot-working nature, corrosion resistance, etc. to required level, since cost starts in order to reduce the amount of S of super-low carbon steel like this invention.

[0029] Although aluminum needs making 0.005% or more contain as a deoxidation element of steel, since big and rough nonmetallic inclusion will be generated and workability will be spoiled if it is made to contain superfluously, as for an upper limit content, it is more desirable to consider as 0.10% and to consider as 0.070% or less from a viewpoint of good steel plate quality.

[0030] Since C and N in steel are fixed as carbide and a nitride, 0.002% or more of addition is required for it, and when Ti is made to contain 0.010% or more, it is more desirable. . which makes an upper limit content 0.10% on the other hand since alloy addition cost only already goes up in vain to the effectiveness being saturated even if it adds exceeding 0.10% -- since it may spoil the workability and surface quality of a steel plate, when the superfluous dissolution Ti considers as 0.050% or less, it is more desirable.

[0031] When an upper limit is made into 0.004% since N reduces workability while it raises the reinforcement of steel, and you need high workability especially, considering as 0.003% or less is more desirable, and it is desirable especially when 0.002% or less. Although more little N is so desirable that there is, since decreasing to less than 0.0005% requires superfluous cost, a minimum content is made into 0.0005%.

[0032] At the invention in this application, since in addition to the above carbide is fixed as an addition component and C and N in steel are further fixed as a nitride, Nb can be added under the aforementioned Ti addition, but in order to demonstrate enough C by Nb addition, and N fixed effect, 0.002% or more needs to be added, and it is more desirable when 0.005% or more. Since cost only already goes up in vain while the effectiveness is saturated even if it adds Nb exceeding 0.10%, an upper limit content is made into 0.10%. Since the recrystallizing temperature of a steel plate is raised and the productivity of hot-dip-zincing Rhine is reduced, when superfluous Nb addition considers as 0.050% or less, it is more desirable.

[0033] In the invention in this application, in making the moldability of a steel plate, and workability high much more further, let the content of Ti be the range with which are satisfied of following the (1) type.

[Equation 5]
[%Ti] ≧4[%C] +3. 4[%N] +1. 5[%S] … (1)

This is because C and N which are the element which checks workability can be effectively fixed by Ti and the workability of a steel plate can be raised, if Ti content is made into the above-mentioned range. Or let the content of Ti and Nb be the range with which are satisfied of following the (2) type and (3) types.
[Equation 6]
([%Ti] +0. 52[%Nb]) ≧4[%C] +3. 4[%N] +
1. 5[%S] … (2)

[%Ti] ≧0. 009% … (3)

Although it is because C and N which are the element which checks workability can be effectively fixed by the compound effectiveness of Ti and Nb and the workability of a steel plate can be raised when this makes the content of Ti and Nb the above-mentioned range If Nb independent addition is not enough as this improvement effectiveness in workability, the compound addition effectiveness of Ti and Nb becomes remarkable and the content of Ti and Nb satisfies (2) types in this case when Ti content is 0.009% or more C and N are effectively fixable by Ti and Nb.
[0034] Although a steel plate can be made to contain B 0.0002 to 0.003% as an addition component further in the invention in this application, this aims at the improvement of secondary elaboration nature. Since a moldability already falls in addition to the effectiveness being saturated even if the content of B adds exceeding 0.003% rather than has an enough secondary elaboration nature improvement effect at less than 0.0002%, in adding B, it makes the range into 0.0002 - 0.003%. When you need high deep drawability especially, when the addition of B is made into 0.0015% or less, it is more desirable.
[0035]
[Example] Hereafter, an example explains this invention concretely.
[0036] (Example 1) First, cold rolled sheet steel with a thickness of 0.8mm was prepared, this was annealed at the pretreatment furnace of continuous system hot-dip-zincing Rhine, after performing hot dipping for 3 seconds by the 460-degree C melting zinc plating bath to which the amount of aluminum under bath was changed, it adjusted to the plating coating weight shown in Table 1 by N2 gas wiping, and skin pass rolling to which roll roughness and rolling rolling reduction were changed was performed. A presentation among a plating layer and surface roughness of the obtained plating steel plate are shown in Table 1.
[0037] In order that a moldability might investigate the sliding nature of plating, it used the metal mold of shoulder R2R, applied commercial slushing oil, and carried out the draw bead trial. It drew out by 1200kg of pressure, and the object which was able to be drawn out was drawn out by O and 1000kg of pressure, and the object which fractured the object which was able to be drawn out in the middle of ** was made into x. Adhesion stuck the cellophane tape on the hot-dipping steel plate after the E. I. du Pont de Nemours impact test, tore it off after that, and made x the case where O and plating exfoliated the case where plating does not exfoliate. The E. I. du Pont de Nemours trial was shot with the radius of circle of 1/2 inch (1.27cm) at the tip, used the mold, and was performed by dropping 1kg weight from height of 1m.
[0038] A result is shown in Table 1. Since this invention was out of range, as for numbers 1 and 8, plating adhesion became [aluminum% under plating] a rejection. Since Ra of this invention on the front face of a steel plate was out of range, as for the number 13, the moldability became a rejection. Since this invention of PPI on the front face of a steel plate was out of range, as for the number 18, the moldability became a rejection. Since Pc of this invention on the front face of a steel plate was out of range, as for the number 23, the moldability became a rejection. Each brought a result with good moldability and plating adhesion except these.

[0039] (Example 2) First, cold rolled sheet steel with a thickness of 0.8mm was prepared, this was annealed at the pretreatment furnace of continuous system hot-dip-zincing Rhine, after performing hot dipping for 3 seconds by the 460-degree C melting zinc plating bath to which the amount of aluminum under bath and the amount of Mg were changed, it adjusted to the plating coating weight shown in Table 2 by N2 gas wiping, and skin pass rolling to which roll roughness and rolling rolling reduction were changed was performed. A presentation among a plating layer and surface roughness of the obtained plating steel plate are shown in Table 2.
[0040] In order that a moldability might investigate the sliding nature of plating, it used the metal mold of shoulder R2R, applied commercial slushing oil, and carried out the draw bead trial. It drew out by 1200kg of pressure, and the object which was able to be drawn out was drawn out by O and 1000kg of pressure, and the object which fractured the object which was able to be drawn out in the middle of ** was made into x. Adhesion stuck the cellophane tape on the hot-dipping steel plate after the E. I. du Pont de Nemours impact test, tore it off after that, and made x the case where O and plating exfoliated the case where plating does not exfoliate. The E. I. du Pont de Nemours trial was shot with the radius of circle of 1/2 inch (1.27cm) at the tip, used the mold, and was performed by dropping 1kg weight from height of 1m.
[0041] A result is shown in Table 2. Since this invention was out of range, as for numbers 1 and 8, plating adhesion became [aluminum% under plating] a rejection. Since Ra of this invention on the front face of a steel plate was out of range, as for the number 21, the moldability became a rejection. Since this invention of PPI on the front face of a steel plate was out of range, as for the number 26, the moldability became a rejection. Since Pc of this invention on the front face of a steel plate was out of range, as for the number 31, the moldability became a rejection. Each brought a result with good moldability and plating adhesion except these.
[0042] (Example 3) First, cold rolled sheet steel with a thickness of 0.8mm was prepared, this was annealed at the pretreatment furnace of continuous system hot-dip-zincing Rhine, after performing hot dipping for 3 seconds by the 460-600-degree C melting zinc plating bath to which the amount of aluminum under bath, the amount of Mg, and the amount of Si were changed, it adjusted to the plating coating weight shown in Table 3 by N2 gas wiping, and skin pass rolling to which roll roughness and rolling rolling reduction were changed was performed. A presentation among a plating layer and surface roughness of the obtained plating steel plate are shown in Table 3.
[0043] In order that a moldability might investigate the sliding nature of plating, it used the metal mold of shoulder R2R, applied commercial slushing oil, and carried out the draw bead trial. It drew out by 1200kg of pressure, and the object which was able to be drawn out was drawn out by O and 1000kg of pressure, and the object which fractured the object which was able to be drawn out in the middle of ** was made into x. Adhesion stuck the cellophane tape on the hot-dipping steel plate after the E. I. du Pont de Nemours impact test, tore it off after that, and made x the case where O and plating exfoliated the case where plating does not exfoliate. The E. I. du Pont de Nemours trial was shot with the radius of circle of 1/2 inch (1.27cm) at the tip, used the mold, and was performed by dropping 1kg weight from height of 1m.
[0044] A result is shown in Table 3. Since this invention was out of range, as for the number 11, plating adhesion became [Si% under plating] a rejection. Since Ra of this invention on the front face of a steel plate was out of range, as for the number 12, the moldability became a rejection. Since this invention of PPI on the front face of a steel plate was out of range, as for the number 17, the moldability became a rejection. Since Pc of this invention on the front face of a steel plate was out of range, as for the number 22, the moldability became a rejection. Each brought a result with good moldability and plating adhesion except these.
[0045] (Example 4) First, cold rolled sheet steel with a thickness of 0.8mm was prepared, this was annealed at the pretreatment furnace of continuous system hot-dip-zincing Rhine, after performing hot dipping for 3 seconds by the 460-600-degree C melting zinc plating bath to which the amount of aluminum under bath, the amount of Mg, and the amount of Si were changed, it adjusted to the plating coating weight shown in Table 4 by N2 gas wiping, and skin pass rolling to which roll roughness and

rolling rolling reduction were changed was performed. A presentation among a plating layer and surface roughness of the obtained plating steel plate are shown in Table 4.
[0046] In order that a moldability might investigate the sliding nature of plating, it used the metal mold of shoulder R1R, and the metal mold of shoulder R2R, applied commercial slushing oil, and carried out the draw bead trial. The metal mold of shoulder R1R was used, the object which was able to be drawn out by 1000kg of pressure was made into O, and the object which fractured the object which was able to be drawn out by 1200kg of pressure using the metal mold of shoulder R2R in the middle of O was made into x. The crystal stacking tendency measured the sample cut to 25x25mm by the theta-2theta method, and the ratios I002/I101 of the integrated intensity I002 of the field observed by d= 2.4730A (002) and the integrated intensity I101 of the field observed by d= 2.0910A (101) were used for it.
[0047] A result is shown in Table 4. . from which, as for numbers 4, 8, 12, 16, and 20, the moldability became a rejection since this invention of PPI on the front face of a steel plate was out of range -- the moldability all brought a good result except these.
[0048] (Example 5) First the cold rolled sheet steel of the component shown in Table 5 It prepares. This It anneals at the pretreatment furnace of continuous system hot-dip-zincing Rhine, and after performing hot dipping for 3 seconds by the 460-600-degree C melting zinc plating bath to which the amount of aluminum under bath, the amount of Mg, and the amount of Si were changed, it adjusts to the plating coating weight shown in Tables 6-8 by N2 gas wiping. Roll roughness and rolling rolling reduction Changed skin pass rolling was performed. A presentation among a plating layer and surface roughness of the obtained plating steel plate are shown in Tables 6-8.
[0049] The crystal stacking tendency measured the sample cut to 25x25mm by the theta-2theta method, and the ratios I002/I101 of the integrated intensity I002 of the field observed by d= 2.4730A (002) and the integrated intensity I101 of the field observed by d= 2.0910A (101) were used for it.
[0050] The moldability used the metal mold of 50mm of diameters of punch, and evaluated it by the cupping test after applying commercial slushing oil. The diameter of a blank and the blank holder load were changed, it evaluated, and ** and the thing from which it did not extract and escape were evaluated for what extracted and escaped from what extracted and escaped from that from which it extracted and escaped with 110mm of diameters of a blank with O and 105mm of diameters of a blank with O and 100mm of diameters of a blank as x.
[0051] A result is shown in Tables 6-8. Since this invention of PPI on the front face of a steel plate was out of range, as for numbers 81-96, the moldability became a rejection. The moldability all brought a good result except these.
[0052]
[Table 1]

表1

試料番号	めっき中のAl%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	備考
1	0.02	60	1.0	220	110	○	×	比較例
2	0.05	60	1.0	220	110	○	○	本発明例
3	0.1	60	1.0	220	110	○	○	〃
4	0.5	60	1.0	220	110	○	○	〃
5	1	60	1.0	220	110	○	○	〃
6	5	60	1.0	220	110	○	○	〃
7	10	60	1.0	220	110	○	○	〃
8	12	60	1.0	220	110	○	×	比較例
9	0.4	30	1.0	220	110	○	○	本発明例
10	0.4	100	1.0	220	110	○	○	〃
11	0.4	150	1.0	220	110	○	○	〃
12	0.5	60	1.0	220	110	○	○	〃
13	0.5	60	0.4	220	110	×	○	比較例
14	0.5	60	0.5	220	110	△	○	本発明例
15	0.5	60	0.7	220	110	○	○	〃
16	0.5	60	1.2	220	110	○	○	〃
17	0.5	60	1.5	220	110	○	○	〃
18	0.5	60	1.0	130	65	×	○	比較例
19	0.5	60	1.0	150	80	△	○	本発明例
20	0.5	60	1.0	200	100	○	○	〃
21	0.5	60	1.0	250	120	○	○	〃
22	0.5	60	1.0	300	140	○	○	〃
23	0.5	60	1.0	220	80	×	○	比較例
24	0.5	60	1.0	220	100	△	○	本発明例

[0053]
[Table 2]

表2

試料番号	めっき中のAl%	めっき中のMg%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	耐食性	備考
1	0.02	0.5	60	1.0	220	110	○	×	○	比較例
2	0.05	0.5	60	1.0	220	110	○	○	〃	本発明例
3	0.1	0.5	60	1.0	220	110	○	○	〃	〃
4	0.5	0.5	60	1.0	220	110	○	○	〃	〃
5	1	0.5	60	1.0	220	110	○	○	〃	〃
6	5	0.5	60	1.0	220	110	○	○	〃	〃
7	10	0.5	60	1.0	220	110	○	○	〃	〃
8	12	0.5	60	1.0	220	110	○	×	〃	比較例
9	0.4	0.5	30	1.0	220	110	○	○	〃	本発明例
10	0.4	0.5	100	1.0	220	110	○	○	〃	〃
11	0.4	0.5	150	1.0	220	110	○	○	〃	〃
12	0.4	0.005	60	1.0	220	110	○	○	△	〃
13	0.4	0.01	60	1.0	220	110	○	○	○	〃
14	0.4	0.1	60	1.0	220	110	○	○	〃	〃
15	5	0.1	60	1.0	220	110	○	○	〃	〃
16	0.4	1	60	1.0	220	110	○	○	〃	〃
17	0.4	3	60	1.0	220	110	○	○	〃	〃
18	6	3	60	1.0	220	110	○	○	〃	〃
19	10	5	60	1.0	220	110	○	○	〃	〃
20	0.5	0.5	60	1.0	220	110	○	○	〃	〃
21	0.5	0.5	60	0.4	220	110	×	○	〃	比較例
22	0.5	0.5	60	0.5	220	110	△	○	〃	本発明例
23	0.5	0.5	60	0.7	220	110	○	○	〃	〃
24	0.5	0.5	60	1.2	220	110	○	○	〃	〃
25	0.5	0.5	60	1.5	220	110	○	○	〃	〃
26	0.5	0.5	60	1.0	130	65	×	○	〃	比較例
27	0.5	0.5	60	1.0	150	80	△	○	〃	本発明例
28	0.5	0.5	60	1.0	200	100	○	○	〃	〃
29	0.5	0.5	60	1.0	250	120	○	○	〃	〃
30	0.5	0.5	60	1.0	300	140	○	○	〃	〃
31	0.5	0.5	60	1.0	220	90	×	○	〃	比較例
32	0.5	0.5	60	1.0	220	100	△	○	〃	本発明例

[0054]
[Table 3]

表3

試料番号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	備考
1	11	3	0.2	60	1.0	220	110	○	○	本発明例
2	11	3	0.2	30	1.0	220	110	○	○	〃
3	11	3	0.2	100	1.0	220	110	○	○	〃
4	11	3	0.2	150	1.0	220	110	○	○	〃
5	4	3	0.1	60	1.0	220	110	○	○	〃
6	20	3	0.3	60	1.0	220	110	○	○	〃
7	10	2	0.2	60	1.0	220	110	○	○	〃
8	10	10	0.6	60	1.0	220	110	○	○	〃
9	11	3	0.01	60	1.0	220	110	○	○	〃
10	20	3	2	60	1.0	220	110	○	○	〃
11	12	3	≦0.001	60	1.0	220	110	○	×	比較例
12	11	3	0.2	60	0.4	220	110	×	○	〃
13	11	3	0.2	60	0.5	220	110	△	○	本発明例
14	11	3	0.2	60	0.7	220	110	○	○	〃
15	11	3	0.2	60	1.2	220	110	○	○	〃
16	11	3	0.2	60	1.5	220	110	○	○	〃
17	11	3	0.2	60	1.0	130	65	×	○	比較例
18	11	3	0.2	60	1.0	150	80	△	○	本発明例
19	11	3	0.2	60	1.0	200	100	○	○	〃
20	11	3	0.2	60	1.0	250	120	○	○	〃
21	11	3	0.2	60	1.0	300	140	○	○	〃
22	11	3	0.2	60	1.0	220	90	×	○	比較例
23	11	3	0.2	60	1.0	220	100	△	○	本発明例

[0055]
[Table 4]

表4

試料番号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
1	0.5	-	-	60	1.0	220	110	1.5	○	本発明例
2	0.5	-	-	60	1.0	220	110	2	◎	〃
3	0.5	-	-	60	1.0	220	110	10	◎	〃
4	0.5	-	-	60	1.0	130	65	7	×	比較例
5	0.5	0.5	-	60	1.0	220	110	1.5	○	本発明例
6	0.5	0.5	-	60	1.0	220	110	2	◎	〃
7	0.5	0.5	-	60	1.0	220	110	10	◎	〃
8	0.5	0.5	-	60	1.0	130	65	7	×	比較例
9	5	0.1	-	60	1.0	220	110	1.5	○	本発明例
10	5	0.1	-	60	1.0	220	110	2	◎	〃
11	5	0.1	-	60	1.0	220	110	10	◎	〃
12	5	0.1	-	60	1.0	130	65	7	×	比較例
13	6	3	-	60	1.0	220	110	1.5	○	本発明例
14	6	3	-	60	1.0	220	110	2	◎	〃
15	6	3	-	60	1.0	220	110	10	◎	〃
16	6	3	-	60	1.0	130	65	7	×	比較例
17	11	3	0.2	60	1.0	220	110	1.5	○	本発明例
18	11	3	0.2	60	1.0	220	110	2	◎	〃
19	11	3	0.2	60	1.0	220	110	10	◎	〃
20	11	3	0.2	60	1.0	130	65	7	×	比較例

[0056]
[Table 5]

表5

記号	化学成分（質量%）										[%Ti] +0.52 [%Nb]	4 [%C] +3.4 [%N] +1.5 [%S]
	C	Si	Mn	P	S	Al	Ti	Nb	N	B		
A	0.0015	0.02	0.15	0.008	0.006	0.035	0.036	-	0.002	-	-	0.0218
B	0.0022	0.01	0.18	0.008	0.004	0.030	0.015	0.020	0.0014	-	0.0254	0.0196
C	0.0020	0.02	0.25	0.009	0.004	0.047	0.010	0.029	0.0021	-	0.0251	0.0211
D	0.0018	0.02	0.25	0.011	0.007	0.027	0.033	-	0.0022	0.0005	-	0.0252
E	0.0029	0.03	0.37	0.008	0.007	0.028	0.012	0.024	0.002	0.0008	0.0266	0.0258
F	0.0016	0.03	0.20	0.005	0.004	0.025	0.029	0.008	0.0018	-	0.0332	0.0189
G	0.0018	0.04	0.16	0.01	0.005	0.031	0.011	0.025	0.0017	-	0.0240	0.0205
H	0.0018	0.02	0.17	0.009	0.006	0.019	0.029	0.009	0.0018	0.0005	0.0337	0.0227
I	0.0016	0.008	0.20	0.003	0.003	0.033	0.024	-	0.0018	-	-	0.0189
J	0.0017	0.01	0.17	0.005	0.003	0.038	0.014	0.026	0.0018	-	0.0276	0.0187
K	0.0016	0.01	0.22	0.004	0.004	0.041	0.032	0.009	0.0017	-	0.0367	0.0182
L	0.0018	0.02	0.10	0.004	0.003	0.088	0.011	0.027	0.0014	0.0004	0.0250	0.0165
M	0.0017	0.01	0.20	0.003	0.003	0.037	0.038	-	0.0015	-	-	0.0164
N	0.0018	0.02	0.15	0.007	0.004	0.033	0.015	0.029	0.0014	-	0.0301	0.0180
O	0.0017	0.01	0.18	0.006	0.002	0.029	0.025	0.010	0.0018	0.0004	0.0302	0.0152
P	0.0330	0.02	0.44	0.021	0.010	0.036	0.014	-	0.0025	-	-	0.1555

[0057]
[Table 6]

表6

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
1	A	0.5	-	-	60	1.0	220	110	4	◎	本発明例
2	B	0.5	-	-	60	1.0	220	110	4	◎	〃
3	C	0.5	-	-	60	1.0	220	110	4	◎	〃
4	D	0.5	-	-	60	1.0	220	110	4	◎	〃
5	E	0.5	-	-	60	1.0	220	110	4	◎	〃
6	F	0.5	-	-	60	1.0	220	110	4	◎	〃
7	G	0.5	-	-	60	1.0	220	110	4	◎	〃
8	H	0.5	-	-	60	1.0	220	110	4	◎	〃
9	I	0.5	-	-	60	1.0	220	110	4	◎	〃
10	J	0.5	-	-	60	1.0	220	110	4	◎	〃
11	K	0.5	-	-	60	1.0	220	110	4	◎	〃
12	L	0.5	-	-	60	1.0	220	110	4	◎	〃
13	M	0.5	-	-	60	1.0	220	110	4	◎	〃
14	N	0.5	-	-	60	1.0	220	110	4	◎	〃
15	O	0.5	-	-	60	1.0	220	110	4	◎	〃
16	P	0.5	-	-	60	1.0	220	110	4	○	〃
17	A	0.5	0.5	-	60	1.0	220	110	4	◎	〃
18	B	0.5	0.5	-	60	1.0	220	110	4	◎	〃
19	C	0.5	0.5	-	60	1.0	220	110	4	◎	〃
20	D	0.5	0.5	-	60	1.0	220	110	4	◎	〃
21	E	0.5	0.5	-	60	1.0	220	110	4	◎	〃
22	F	0.5	0.5	-	60	1.0	220	110	4	◎	〃
23	G	0.5	0.5	-	60	1.0	220	110	4	◎	〃
24	H	0.5	0.5	-	60	1.0	220	110	4	◎	〃
25	I	0.5	0.5	-	60	1.0	220	110	4	◎	〃
26	J	0.5	0.5	-	60	1.0	220	110	4	◎	〃
27	K	0.5	0.5	-	60	1.0	220	110	4	◎	〃
28	L	0.5	0.5	-	60	1.0	220	110	4	◎	〃
29	M	0.5	0.5	-	60	1.0	220	110	4	◎	〃
30	N	0.5	0.5	-	60	1.0	220	110	4	◎	〃
31	O	0.5	0.5	-	60	1.0	220	110	4	◎	〃

[0058]
[Table 7]

表7

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
32	P	0.5	0.5	-	60	1.0	220	110	4	○	本発明例
33	A	5	0.1	-	60	1.0	220	110	4	◎	〃
34	B	5	0.1	-	60	1.0	220	110	4	◎	〃
35	C	5	0.1	-	60	1.0	220	110	4	◎	〃
36	D	5	0.1	-	60	1.0	220	110	4	◎	〃
37	E	5	0.1	-	60	1.0	220	110	4	◎	〃
38	F	5	0.1	-	60	1.0	220	110	4	◎	〃
39	G	5	0.1	-	60	1.0	220	110	4	◎	〃
40	H	5	0.1	-	60	1.0	220	110	4	◎	〃
41	I	5	0.1	-	60	1.0	220	110	4	◎	〃
42	J	5	0.1	-	60	1.0	220	110	4	◎	〃
43	K	5	0.1	-	60	1.0	220	110	4	◎	〃
44	L	5	0.1	-	60	1.0	220	110	4	◎	〃
45	M	5	0.1	-	60	1.0	220	110	4	◎	〃
46	N	5	0.1	-	60	1.0	220	110	4	◎	〃
47	O	5	0.1	-	60	1.0	220	110	4	◎	〃
48	P	5	0.1	-	60	1.0	220	110	4	○	〃
49	A	6	3	-	60	1.0	220	110	4	◎	〃
50	B	6	3	-	60	1.0	220	110	4	◎	〃
51	C	6	3	-	60	1.0	220	110	4	◎	〃
52	D	6	3	-	60	1.0	220	110	4	◎	〃
53	E	6	3	-	60	1.0	220	110	4	◎	〃
54	F	6	3	-	60	1.0	220	110	4	◎	〃
55	G	6	3	-	60	1.0	220	110	4	◎	〃
56	H	6	3	-	60	1.0	220	110	4	◎	〃
57	I	6	3	-	60	1.0	220	110	4	◎	〃
58	J	6	3	-	60	1.0	220	110	4	◎	〃
59	K	6	3	-	60	1.0	220	110	4	◎	〃
60	L	6	3	-	60	1.0	220	110	4	◎	〃
61	M	6	3	-	60	1.0	220	110	4	◎	〃
62	N	6	3	-	60	1.0	220	110	4	◎	〃
63	O	6	3	-	60	1.0	220	110	4	◎	〃
64	P	6	3	-	60	1.0	220	110	4	○	〃
65	A	11	3	0.2	60	1.0	220	110	3	◎	〃

[0059]
[Table 8]

表8

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
66	B	11	3	0.2	60	1.0	220	110	3	◎	本発明例
67	C	11	3	0.2	60	1.0	220	110	3	◎	〃
68	D	11	3	0.2	60	1.0	220	110	3	◎	〃
69	E	11	3	0.2	60	1.0	220	110	3	◎	〃
70	F	11	3	0.2	60	1.0	220	110	3	◎	〃
71	G	11	3	0.2	60	1.0	220	110	3	◎	〃
72	H	11	3	0.2	60	1.0	220	110	3	◎	〃
73	I	11	3	0.2	60	1.0	220	110	3	◎	〃
74	J	11	3	0.2	60	1.0	220	110	3	◎	〃
75	K	11	3	0.2	60	1.0	220	110	3	◎	〃
76	L	11	3	0.2	60	1.0	220	110	3	◎	〃
77	M	11	3	0.2	60	1.0	220	110	3	◎	〃
78	N	11	3	0.2	60	1.0	220	110	3	◎	〃
79	O	11	3	0.2	60	1.0	220	110	3	◎	〃
80	P	11	3	0.2	60	1.0	220	110	3	○	〃
81	A	0.5	-	-	60	1.0	130	65	2	△	比較例
82	B	0.5	-	-	60	1.0	130	65	2	△	〃
83	C	0.5	-	-	60	1.0	130	65	2	△	〃
84	D	0.5	-	-	60	1.0	130	65	2	△	〃
85	E	0.5	-	-	60	1.0	130	65	2	△	〃
86	F	0.5	-	-	60	1.0	130	65	2	△	〃
87	G	0.5	-	-	60	1.0	130	65	2	△	〃
88	H	0.5	-	-	60	1.0	130	65	2	△	〃
89	I	0.5	-	-	60	1.0	130	65	2	△	〃
90	J	0.5	-	-	60	1.0	130	65	2	△	〃
91	K	0.5	-	-	60	1.0	130	65	2	△	〃
92	L	0.5	-	-	60	1.0	130	65	2	△	〃
93	M	0.5	-	-	60	1.0	130	65	2	△	〃
94	N	0.5	-	-	60	1.0	130	65	2	△	〃
95	O	0.5	-	-	60	1.0	130	65	2	△	〃
96	P	0.5	-	-	60	1.0	130	65	2	×	〃

[0060]

[Effect of the Invention] As mentioned above, as stated, according to this invention, an oxide can be made to be able to generate, or the hot-dip zinc-coated carbon steel sheet excellent in the moldability can be manufactured, without needing the facility in which a coat is made to form, and very big effectiveness is done so on industry.

[Translation done.]

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最終頁に続く

(54)【発明の名称】　成形性に優れた溶融亜鉛めっき鋼板

(57)【要約】
【課題】　酸化物を生成させたり、被膜を形成させたりする設備を必要とせずに、成形性に優れた溶融亜鉛めっき鋼板を提供すること。
【解決手段】　Ａｌ：０．０５～１０重量%、必要に応じてＭｇ：０．０１～５重量%、更にＳｉ：０．０１～２重量%を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μm，ＰＰＩ（１インチ（２．５４cm）あたりに含まれる１．２７μm以上の大きさのピークの数）が１５０～３００，Ｐｃ（１cmあたりに含まれる０．５μm以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

1

【特許請求の範囲】

【請求項１】　Ａｌ：０．０５～１０質量％を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μｍ，ＰＰＩ（１インチ（２．５４ｃｍ）あたりに含まれる１．２７μｍ以上の大きさのピークの数）が１５０～３００，Ｐｃ（１ｃｍあたりに含まれる０．５μｍ以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

【請求項２】　Ａｌ：０．０５～１０質量％，Ｍｇ：０．０１～５質量％を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μｍ，ＰＰＩ（１インチ（２．５４ｃｍ）あたりに含まれる１．２７μｍ以上の大きさのピークの数）が１５０～３００，Ｐｃ（１ｃｍあたりに含まれる０．５μｍ以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

【請求項３】　Ａｌ：４～２０質量％，Ｍｇ：２～１０質量％，Ｓｉ：０．０１～２質量％を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μｍ，ＰＰＩ（１インチ（２．５４ｃｍ）あたりに含まれる１．２７μｍ以上の＊大きさのピークの数）が１５０～３００，Ｐｃ（１ｃｍあたりに含まれる０．５μｍ以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

【請求項４】　めっき層のＺｎ結晶のミラー指数（００２）面と（１０１）面のＸ線回折強度比が２以上であることを特徴とする請求項１～３のいずれか１つに記載の成形性に優れた溶融亜鉛めっき鋼板。

【請求項５】　鋼中添加元素の含有量が質量％で，Ｃ：０．０００１～０．００４％，Ｓｉ：０．００１～０．１０％，Ｍｎ：０．０１～０．５０％，Ｐ：０．００１～０．０１５％，Ｓ：０．０１５％以下，Ａｌ：０．００５～０．１０％，Ｔｉ：０．００２～０．１０％，Ｎ：０．０００５～０．００４％，を含有し，残部Ｆｅおよび不可避不純物からなることを特徴とする請求項１～４のいずれか１つに記載の成形性に優れた溶融亜鉛めっき鋼板。

【請求項６】　鋼板が付加成分としてさらに，質量％で，Ｎｂ：０．００２～０．１０％を含有することを特徴とする請求項５に記載の成形性に優れた溶融亜鉛めっき鋼板。

【請求項７】　鋼中Ｔｉ含有量が，下記（１）式（［％Ｘ］は，質量％で表わした合金元素Ｘの含有量）で与えられる条件を満足することを特徴とする請求項５に記載の成形性に優れた溶融亜鉛めっき鋼板。

【数１】

$$[\%Ti] \geqq 4[\%C] + 3.4[\%N] + 1.5[\%S] \cdots (1)$$

【請求項８】　鋼中ＴｉおよびＮｂの含有量が，下記（２）～（３）式（[％Ｘ]は，質量％で表わした合金元素Ｘの含有量）で与えられる条件を満足することを特徴※とする請求項６に記載の成形性に優れた溶融亜鉛めっき鋼板。

【数２】

$$([\%Ti] + 0.52[\%Nb]) \geqq 4[\%C] + 3.4[\%N] + 1.5[\%S] \cdots (2)$$

$$[\%Ti] \geqq 0.009\% \cdots (3)$$

【請求項９】　鋼板が付加成分としてさらに，質量％で，Ｂ：０．０００２～０．００３％を含有することを特徴とする請求項５～８のいずれか１つに記載の溶融亜鉛めっき鋼板。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は，溶融亜鉛めっき鋼板に係わり，更に詳しくは優れた成形性を有し，種々の用途，例えば建材用や自動車用鋼板として適用できるめっき鋼板に関するものである。

【０００２】

【従来の技術】耐食性の良好なめっき鋼板として溶融亜鉛めっき鋼板がある。この溶融亜鉛めっき鋼板は，通常，鋼板を脱脂後，無酸化炉にて予熱し，表面の清浄化★および材質確保のために還元炉にて還元焼鈍を行い，溶融亜鉛浴に浸漬し，付着量制御することによって製造される。その特徴として，耐食性およびめっき密着性等に優れることから，自動車，建材用途等を中心として広く使用されている。

【０００３】特に自動車用鋼板の場合には，複雑な成形加工を受けて自動車に組み込まれるため，優れた成形性が要求される．また，溶融亜鉛めっき鋼板は合金化溶融亜鉛めっき鋼板に比べ，めっきが柔らかいため金型とかじり易く摺動性を向上させる必要がある。

【０００４】溶融亜鉛めっき鋼板の摺動性を向上させる技術としては，特開平４－３２５６６５号公報のごとく表面にＺｎＯを主体とする２０～３０００ｍｇ／ｍ²の酸化物を生成させる技術，特開平３－２４９１８０号公

報のごとく亜鉛系めっき鋼板表面に，特定量のＭｎ酸化物と，特定量のリン酸とＭｏ酸化物等とを含有する皮膜を被覆する技術，特開平９－１１１４７３号公報のごとく潤滑作用を有する化合物を含む被覆組成物を形成させる技術，特開２０００－２５６８７４号公報のごとくリン酸化物系無機皮膜を形成させる技術等が挙げられる。

【０００５】

【発明が解決しようとする課題】しかし，上記技術では酸化物を生成させたり，被膜を形成させる設備が必要となるため，そのスペースがない場合は採用できない。又こうした設備設置により生産コストが上昇する問題も生じる。そこで，本発明は，上記問題点を解決して，成形性に優れた溶融亜鉛めっき鋼板とその製造方法を提供するものである。

【０００６】

【課題を解決するための手段】本発明者らは，成形性に優れた溶融亜鉛めっき鋼板について鋭意研究を重ねた結果，めっき鋼板表面の粗度を制御することにより溶融亜鉛めっき鋼板の成形性を向上させることができることを見いだして本発明をなした。また，めっき層のＺｎ結晶の特定面の配向性が強い場合，さらに成形性を向上させることを見いだして本発明をなした。

【０００７】すなわち，本発明の要旨とするところは，次のとおりである。

（１）　Ａｌ：０．０５～１０質量%を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μm，ＰＰＩ（１インチ（２．５４cm）あたりに含まれる１．２７μm以上の大きさのピークの数）が１５０～３００，Ｐｃ（１cmあたりに含まれる０．５μm以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

（２）　Ａｌ：０．０５～１０質量%，Ｍｇ：０．０１～５質量%を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μm，ＰＰＩ（１インチ（２．５４cm）あたり＊に含まれる１．２７μm以上の大きさのピークの数）が１５０～３００，Ｐｃ（１cmあたりに含まれる０．５μm以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

（３）　Ａｌ：４～２０質量%，Ｍｇ：２～１０質量%，Ｓｉ：０．０１～２質量%を含有し，残部がＺｎおよび不可避的不純物からなる亜鉛めっき層を有する溶融亜鉛めっき鋼板において，該めっき鋼板表面の中心線平均粗さＲａが０．５～１．５μm，ＰＰＩ（１インチ（２．５４cm）あたりに含まれる１．２７μm以上の大きさのピークの数）が１５０～３００，Ｐｃ（１cmあたりに含まれる０．５μm以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることを特徴とする成形性に優れた溶融亜鉛めっき鋼板。

（４）　めっき層のＺｎ結晶のミラー指数（００２）面と（１０１）面のＸ線回折強度比が２以上であることを特徴とする前記（１）～（３）に記載の成形性に優れた溶融亜鉛めっき鋼板。

（５）　鋼中添加元素の含有量が質量%で，Ｃ：　０．０００１～０．００４%，Ｓｉ：０．００１～０．１０%，Ｍｎ：０．０１～０．５０%，Ｐ：　０．００１～０．０１５%，Ｓ：　０．０１５%以下，Ａｌ：０．００５～０．１０%，Ｔｉ：０．００２～０．１０%，Ｎ：　０．０００５～０．００４%，を含有し，残部Ｆｅおよび不可避不純物からなることを特徴とする前記（１）～（４）に記載の成形性に優れた溶融亜鉛めっき鋼板。

（６）　鋼板が付加成分としてさらに，質量%で，Ｎｂ：０．００２～０．１０%を含有することを特徴とする前記（５）に記載の成形性に優れた溶融亜鉛めっき鋼板。

（７）　鋼中Ｔｉ含有量が，下記（１）式（〔％X〕は，質量%で表わした合金元素Ｘの含有量）で与えられる条件を満足することを特徴とする前記（５）に記載の成形性に優れた溶融亜鉛めっき鋼板。

【数３】

$$[\%Ti] \geqq 4[\%C] + 3.4[\%N] + 1.5[\%S] \cdots (1)$$

※前記（６）に記載の成形性に優れた溶融亜鉛めっき鋼板。

【数４】

$$([\%Ti] + 0.52[\%Nb]) \geqq 4[\%C] + 3.4[\%N] + 1.5[\%S] \cdots (2)$$

$$[\%Ti] \geqq 0.009\% \cdots (3)$$

（９）　鋼板が付加成分としてさらに，質量%で，Ｂ：　０．０００２～０．００３%を含有することを特徴とす★る前記（５）～（８）に記載の溶融亜鉛めっき鋼板。

【０００８】

【発明の実施の形態】以下に本発明を詳細に説明する。本発明において溶融亜鉛めっき鋼板とは鋼板上にZn－Alめっき層を付与したもの，Zn－Al－Mgめっき層を付与したもの，及びZn－Al－Mg－Siめっき層を付与したものである。

【０００９】本発明においてZn－Alめっき層及びZn－Al－Mgめっき層のＡｌ組成を０．０５～１０質量%に限定した理由は，０．０５質量%未満のＡｌ量で通常の溶融めっき処理を行うと，めっき処理時においてＺｎ－Ｆｅ合金化反応が起こり，地鉄界面に脆い合金層が発達し，めっき密着性が劣化するためであり，１０質量%を超えるとＦｅ－Ａｌ合金層の成長が顕著となりめっき密着性を阻害するためである。

【００１０】Zn－Al－Mgめっき層のＭｇ組成を０．０１～５質量%に限定した理由は，０．０１質量%未満では耐食性を向上する効果が見られないためであり，５質量%を超えるとめっき浴中にドロスが多量に発生し製造が困難となるためである。

【００１１】また，本発明において高Ａｌ高Ｍｇ組成の溶融亜鉛めっき浴では，低温でＳｉを溶解させることが可能となる。この溶融亜鉛めっき浴にSiを添加するとＦｅ－Ａｌ合金層の成長を抑制するため，Ａｌの添加量を増加させることが可能となる．さらにＡｌの添加量を増加させるとＭｇの添加によるめっき浴中のドロス発生を抑制することができ，Ｍｇの添加量を増加させることが可能となる。

【００１２】本発明においてZn－Al－Mg－Siめっき層のＡｌ組成を４～２０質量%に限定した理由は，４質量%未満のＡｌ量では，めっき浴中にＳｉを溶解させる効果が見られないと共にＭｇの添加によるめっき浴中のドロス発生を抑制する効果が見られないためであり，２０質量%を超えるとめっき浴の融点が上昇し製造が困難となるためである。

【００１３】Ｍｇ組成を２～１０質量%に限定した理由は，２質量%未満ではめっき浴中にＳｉを溶解させる効果が見られないためであり，１０質量%を超えるとめっき浴中にドロスが多量に発生し製造が困難となるためである。

【００１４】Ｓｉ組成を０．０１～２質量%に限定した理由は，０．０１質量%未満ではＦｅ－Ａｌ合金層の成長を抑制する効果が見られないためであり，２質量%を超えるとめっき浴の融点が上昇し製造が困難となるためである。

【００１５】また，さらに，めっき浴中には，通常利用される微量添加元素として，Ｆｅ，Ｎｉ，Ｓｂ，Ｐｂ，Ｓｎ，Ｃｕを含んでいても，本発明の効果に特に影響はない。めっき付着量についても，特に制約は設けないが，耐食性の観点から片面１０ｇ／m^2 以上，加工性の観点からすると片面１５０ｇ／m^2 以下であることが望ましい。なお，下地の鋼板としては，熱延鋼板，冷延鋼板共に使用できるが，特に後述するＴｉ，Ｎｂ，Ｂなどを添加した極低炭素系の鋼板は加工性が優れており望ましい。

【００１６】本発明において，めっき鋼板の製造方法については特に限定するところはなく，通常の無酸化炉方式の溶融めっき法が適用できる。

【００１７】めっき鋼板表面の粗度は，中心線平均粗さＲａ（ＪＩＳ　Ｂ　０６０１規格）で０．５～１．５μｍ，及びＰＰＩ（１インチ（２．５４cm）当たりに含まれる１．２７μｍ以上の大きさのピークの数，ＳＡＥ，Ｊ９１１規格）で１５０～３００，且つＰｃ（１ｃｍ当たりに含まれる０．５μｍ以上の大きさのピークの数）がＰｃ≧ＰＰＩ／２．５４＋１０であることが好ましい。ここでピークの数とは，粗さ曲線の平均線から，正負，両方向に一定の基準レベルＨを設け，負の基準レベルを越えたあと，正の基準レベルを越えたときを１カウントとし，このカウントを評価長さＬｎに達するまで繰り返し，数えた個数で表示したものである。ＰＰＩは基準レベル間の幅２Ｈを１．２７μｍとし，評価長さを１インチ（２．５４cm）として測定した。Ｐｃは基準レベル間の幅２Ｈを０．５μｍとし，評価長さを１ｃｍとして測定した。

【００１８】本発明において，Ｒａを０．５～１．５μｍ，ＰＰＩを１５０～３００，Ｐｃ≧ＰＰＩ／２．５４＋１０に限定した理由は，Ｒａで０．５μｍ未満，ＰＰＩ１５０未満，Ｐｃ７０未満では，成形時の摺動面に型かじりが起こり易く，潤滑性が低下するためであり，Ｒａで１．５μｍ，ＰＰＩ３００を超える粗度を付与するためには，高圧下が必要であり材質の低下に繋がるためである。好ましくはＲａで０．７μｍ以上，ＰＰＩで２００以上である。また，Ｐｃ≧ＰＰＩ／２．５４＋１０に限定した理由は，Ｐｃ＜ＰＰＩ／２．５４＋１０では摺動性の向上が十分ではないためである．Ｐｃ≧ＰＰＩ／２．５４＋１０で摺動性が向上する理由は明らかではないが，摺動性向上には深い凹凸のみでは不十分であり，深い凹凸と中程度の凹凸をある程度バランスさせておくことにより，潤滑油保持性を上げることができると考えられる。元々めっき作製時に凹凸が適当な深さで分布している合金化溶融亜鉛めっきと違い，溶融亜鉛めっきはめっき直後にはほとんど凹凸がないため，粗度を付与する際，この深い凹凸と中程度の凹凸をある程度バランスさせることは極めて重要である．好ましくはＰｃ≧ＰＰＩ／２．５４＋２０である。

【００１９】上記めっき鋼板の表面粗度は，めっき後スキンパス圧延のロール粗度，スキンパス圧延圧下率等によって制御することができる。但し，高Ｒａ，高ＰＰＩを目的として粗度の大きなスキンパスロールを使用すると，めっきの表面は深い凹凸のみとなり，摺動性向上に重要な中程度の凹凸が得られなくなるため，上記粗度を得るためには，深い凹凸と中程度の凹凸を適度にバラン

スさせたロールを使用するか，深い凹凸のロールと中程度の凹凸のロールを組み合わせて使用し目的の粗度を得る必要がある。

【００２０】本発明において，さらに摺動性を向上させるためには，めっき層のＺｎ結晶のミラー指数（００２）面と（１０１）面のＸ線回折強度比を２以上とすることが有効である。ミラー指数（００２）面はＺｎ結晶格子のなかで最も密度の高い面であるため，（００２）面の配向性を高めることによりめっき表面の摺動性が向上すると考えられる。めっき層のＺｎ結晶のミラー指数（００２）面と（１０１）面のＸ線回折強度比が２未満ではこの摺動性向上効果が十分ではないが，このＸ線回折強度比が２以上では明確な摺動性の向上が認められる。

【００２１】下地の鋼板としては，熱延鋼板，冷延鋼板共に使用でき，何れの鋼板においてもめっきに本発明の粗度を付与することにより潤滑性を向上することができ，さらにＺｎ結晶の特定面の配向性が強いめっき層を形成させることにより成形性を向上させることができるが，特に深絞り性の優れた極低炭素系の鋼板に本発明のめっき層を付与するとその効果は著しい。一般に冷延鋼板の深絞り性はｒ値が大きいほど良好であるが，めっき鋼板では冷延鋼板ほどｒ値の影響が顕著でない。これは，深絞り性に与えるめっき表面の潤滑性の影響の方がｒ値の影響より大きいためであり，めっき表面の潤滑性を向上させることによって鋼板が本来持つ性能を引き出すことが可能となる。

【００２２】本発明において極低炭素系の鋼板とは，鋼中添加元素の含有量が質量％で，Ｃ：　０．０００１～０．００４％，Ｓｉ：０．００１～０．１０％，Ｍｎ：０．０１～０．５０％，Ｐ：　０．００１～０．０１５％，Ｓ：　０．０１５％以下，Ａｌ：０．００５～０．１０％，Ｔｉ：０．００２～０．１０％，Ｎ：　０．０００５～０．００４％，を含有し，残部Ｆｅおよび不可避不純物からなる鋼板，及び上記鋼板に、Ｎｂ：０．００２～０．１０％をさらに添加した鋼板，及びこれらの鋼板に、Ｂ：０．０００２～０．００３％をさらに添加した鋼板のことである。

【００２３】次に本発明において，Ｃ，Ｓｉ，Ｍｎ，Ｐ，Ｓ，Ａｌ，Ｔｉ，Ｎ，Ｎｂ，Ｂの数値を限定した理由を以下に示す。尚，以下に示す％はいずれも質量％を表す。

【００２４】Ｃは鋼の強度を高める元素であって０．０００１％以上を含有させることが有効であるが，過剰に含有すると強度が上昇しすぎて加工性が低下するので上限含有量は０．００４％とする。特に高い加工性を必要とする場合には，Ｃ含有量は０．００３％以下とすることが好ましく，０．００２％以下とすると特に好ましい。

【００２５】Ｓｉも鋼の強度を向上させる元素であって

０．００１％以上を含有させるが，過剰に含有すると加工性および溶融亜鉛めっき性を損なうので，上限は０．１０％とする。特に高い加工性を必要とする場合には，Ｓｉ含有量は０．０５％以下とする。

【００２６】Ｍｎも鋼の強度を高める一方で加工性を低下させる元素であるので，上限含有量は０．５０％とする。Ｍｎが少ないほど加工性は良好であるが，０．０１％未満とするためには精練コストが多大となるので下限含有量は０．０１％とする。強度，加工性とコストのバランスからは，Ｍｎ含有量は０．０５～０．３０％とすることがより好ましい。

【００２７】Ｐも鋼の強度を高める一方で加工性を低下させる元素であるので，上限含有量は０．０１５％とする。Ｐが少ないほど加工性は良好であり，０．０１０％以下とするとより好ましい，一方，Ｐ含有量を０．００１％未満に低減するためには精練コストが多大となるので，下限含有量は０．００１％とする。強度，加工性とコストのバランスからはＰ含有量は０．００３～０．０１０％とすることがより好ましい。

【００２８】Ｓは鋼の熱間加工性，耐食性を低下させる元素であるから少ないほど好ましく，上限含有量は０．０１５％とし，より好ましくは０．０１０％以下とする。但し，本発明のような極低炭素鋼のＳ量を低減するためにはコストがかかるので，加工性およびめっき密着性の観点からはＳを過度に低減する必要はなく，熱間加工性，耐食性等から必要なレベルにまでＳを低減すれば良い。

【００２９】Ａｌは鋼の脱酸元素として０．００５％以上を含有させることが必要であるが，過剰に含有させると粗大な非金属介在物を生成して加工性を損なうので，上限含有量は０．１０％とし，良好な鋼板品質の観点からは０．０７０％以下とすることがより好ましい。

【００３０】Ｔｉは鋼中のＣおよびＮを炭化物，窒化物として固定するために，０．００２％以上の添加が必要であり，０．０１０％以上含有させるとより好ましい。一方，０．１０％を超えて添加してももはやその効果は飽和しているのに対して，いたずらに合金添加コストが上昇するだけであるので，上限含有量は０．１０％とする．過剰な固溶Ｔｉは鋼板の加工性および表面品質を損なう場合があるので，０．０５０％以下とするとより好ましい。

【００３１】Ｎは鋼の強度を上昇させる一方で加工性を低下させるので上限は０．００４％とし，特に高い加工性を必要とする場合には０．００３％以下とすることがより好ましく，０．００２％以下とすると特に好ましい。Ｎはより少ないほど好ましいが，０．０００５％未満に低減することは過剰なコストを要するので，下限含有量は０．０００５％とする。

【００３２】本願発明では上記に加えて，さらに付加成分として，鋼中のＣおよびＮを炭化物，窒化物として固

定するために，前記のＴｉ添加のもとでＮｂを添加することができるが，Ｎｂ添加によるＣ，Ｎ固定効果を充分発揮させるためには０．００２％以上の添加が必要であり，０．００５％以上とするとより好ましい。Ｎｂを０．１０％を超えて添加しても，もはやその効果は飽和している一方，いたずらにコストが上昇するだけであるので，上限含有量は０．１０％とする。過剰なＮｂ添加＊は，これは，Ｔｉ含有量を上記の範囲とすると，加工性を阻害する元素であるＣおよびＮをＴｉで有効に固定し，鋼板の加工性を高めることができるからである。あるい　※

[％Ｔｉ]≧４[％Ｃ]＋３．４[％Ｎ]＋１．５[％Ｓ]　…　（１）

※は，ＴｉおよびＮｂの含有量を下記（２）式および（３）式を満足する範囲とする。

【数６】

([％Ｔｉ]＋０．５２[％Ｎｂ])≧４[％Ｃ]＋３．４[％Ｎ]＋１．５[％Ｓ]　…　（２）

[％Ｔｉ]≧０．００９％　…　（３）

これは，ＴｉおよびＮｂの含有量を上記の範囲とすると，加工性を阻害する元素であるＣおよびＮをＴｉとＮｂの複合効果で有効に固定し，鋼板の加工性を高めることができるからであるが，Ｎｂ単独の添加ではかかる加工性向上効果は充分ではなく，Ｔｉ含有量が０．００９％以上である場合にＴｉとＮｂの複合添加効果が顕著となり，この場合においてＴｉおよびＮｂの含有量が（２）式を満足すると，ＣおよびＮをＴｉとＮｂとで有効に固定することができる。

【００３４】本願発明においてはさらに，鋼板に付加成分として，Ｂを０．０００２～０．００３％含有させることができるが，これは２次加工性の改善を目的としている。Ｂの含有量が０．０００２％未満では２次加工性改善効果が充分ではなく，０．００３％を超えて添加してももはやその効果は飽和しているのに加えて，成形性が低下するので，Ｂを添加する場合にはその範囲は０．０００２～０．００３％とする。特に高い深絞り性を必要とする場合には，Ｂの添加量は０．００１５％以下とするとより好ましい。

【００３５】

【実施例】以下，実施例により本発明を具体的に説明する．

【００３６】（実施例１）まず，厚さ0.8㎜の冷延鋼板を準備し，これを連続式溶融亜鉛めっきラインの前処理炉にて焼鈍し，浴中のＡｌ量を変化させた４６０℃の溶融亜鉛めっき浴で３秒溶融めっきを行った後，N_2ガスワイピングで表１に示すめっき付着量に調整し，ロール粗度，圧延圧下率を変化させたスキンパス圧延を行った。得られためっき鋼板のめっき層中組成と表面粗度を表１に示す。

【００３７】成形性はめっきの摺動性を調べるため，肩Ｒ２Ｒの金型を使用し，市販の防錆油を塗布してドロービード試験を実施した。押し付け力１２００ｋｇで引き★抜き，引き抜けた物を○，押し付け力１０００ｋｇで引き抜き，引き抜けた物を△，途中で破断した物を×とした。密着性は，デュポン衝撃試験後の溶融めっき鋼板にセロハンテープを貼り，その後引き剥がし，めっきが剥離しなかった場合を○，めっきが剥離した場合を×とした。デュポン試験は先端に１／２インチ（１．２７㎝）の丸みを持つ撃ち型を使用し，１ｋｇの重りを１ｍの高さから落下させて行った。

【００３８】結果を表１に示す。番号１，８はめっき中のＡｌ％が本発明の範囲外であるためめっき密着性が不合格となった。番号１３は鋼板表面のＲａが本発明の範囲外であるため成形性が不合格となった。番号１８は鋼板表面のＰＰＩが本発明の範囲外であるため成形性が不合格となった。番号２３は鋼板表面のＰｃが本発明の範囲外であるため成形性が不合格となった。これら以外はいずれも，成形性，めっき密着性共に良好な結果となった。

【００３９】（実施例２）まず，厚さ0.8㎜の冷延鋼板を準備し，これを連続式溶融亜鉛めっきラインの前処理炉にて焼鈍し，浴中のＡｌ量，Ｍｇ量を変化させた４６０℃の溶融亜鉛めっき浴で３秒溶融めっきを行った後，N_2ガスワイピングで表２に示すめっき付着量に調整し，ロール粗度，圧延圧下率を変化させたスキンパス圧延を行った。得られためっき鋼板のめっき層中組成と表面粗度を表２に示す。

【００４０】成形性はめっきの摺動性を調べるため，肩Ｒ２Ｒの金型を使用し，市販の防錆油を塗布してドロービード試験を実施した。押し付け力１２００ｋｇで引き抜き，引き抜けた物を○，押し付け力１０００ｋｇで引き抜き，引き抜けた物を△，途中で破断した物を×とした。密着性は，デュポン衝撃試験後の溶融めっき鋼板にセロハンテープを貼り，その後引き剥がし，めっきが剥離しなかった場合を○，めっきが剥離した場合を×とし

た。デュポン試験は先端に１／２インチ（１．２７㎝）の丸みを持つ撃ち型を使用し，１ｋｇの重りを１ｍの高さから落下させて行った。

【００４１】結果を表２に示す。番号１，８はめっき中のＡｌ％が本発明の範囲外であるためめっき密着性が不合格となった。番号２１は鋼板表面のＲａが本発明の範囲外であるため成形性が不合格となった。番号２６は鋼板表面のＰＰＩが本発明の範囲外であるため成形性が不合格となった。番号３１は鋼板表面のＰｃが本発明の範囲外であるため成形性が不合格となった。これら以外はいずれも，成形性，めっき密着性共に良好な結果となった。

【００４２】（実施例３）まず，厚さ0.8㎜の冷延鋼板を準備し，これを連続式溶融亜鉛めっきラインの前処理炉にて焼鈍し，浴中のＡｌ量，Ｍｇ量，Ｓｉ量を変化させた４６０～６００℃の溶融亜鉛めっき浴で３秒溶融めっきを行った後，N_2ガスワイピングで表３に示すめっき付着量に調整し，ロール粗度，圧延圧下率を変化させたスキンパス圧延を行った。得られためっき鋼板のめっき層中組成と表面粗度を表３に示す。

【００４３】成形性はめっきの摺動性を調べるため，肩Ｒ２Ｒの金型を使用し，市販の防錆油を塗布してドロービード試験を実施した。押し付け力１２００ｋｇで引き抜き，引き抜けた物を○，押し付け力１０００ｋｇで引き抜き，引き抜けた物を△，途中で破断した物を×とした。密着性は，デュポン衝撃試験後の溶融めっき鋼板にセロハンテープを貼り，その後引き剥がし，めっきが剥離しなかった場合を○，めっきが剥離した場合を×とした。デュポン試験は先端に１／２インチ（１．２７㎝）の丸みを持つ撃ち型を使用し，１ｋｇの重りを１ｍの高さから落下させて行った。

【００４４】結果を表３に示す。番号１１はめっき中のＳｉ％が本発明の範囲外であるためめっき密着性が不合格となった。番号１２は鋼板表面のＲａが本発明の範囲外であるため成形性が不合格となった。番号１７は鋼板表面のＰＰＩが本発明の範囲外であるため成形性が不合格となった。番号２２は鋼板表面のＰｃが本発明の範囲外であるため成形性が不合格となった。これら以外はいずれも，成形性，めっき密着性共に良好な結果となった。

【００４５】（実施例４）まず，厚さ0.8㎜の冷延鋼板を準備し，これを連続式溶融亜鉛めっきラインの前処理炉にて焼鈍し，浴中のＡｌ量，Ｍｇ量，Ｓｉ量を変化させた４６０～６００℃の溶融亜鉛めっき浴で３秒溶融めっきを行った後，N_2ガスワイピングで表４に示すめっき付着量に調整し，ロール粗度，圧延圧下率を変化させたスキンパス圧延を行った。得られためっき鋼板のめっき層中組成と表面粗度を表４に示す。

【００４６】成形性はめっきの摺動性を調べるため，肩Ｒ１Ｒの金型と肩Ｒ２Ｒの金型を使用し，市販の防錆油を塗布してドロービード試験を実施した。肩Ｒ１Ｒの金型を使用し，押し付け力１０００ｋｇで引き抜けた物を◎とし，肩Ｒ２Ｒの金型を使用し押し付け力１２００ｋｇで引き抜けた物を○，途中で破断した物を×とした。結晶配向性は，２５×２５ｍｍに切断したサンプルを$\theta-2\theta$法により測定し，ｄ＝２．４７３０Åに観察される（００２）面の積分強度I_{002}とｄ＝２．０９１０Åに観察される（１０１）面の積分強度I_{101}の比I_{002}/I_{101}を使用した。

【００４７】結果を表４に示す。番号４，８，１２，１６，２０は鋼板表面のＰＰＩが本発明の範囲外であるため成形性が不合格となった．これら以外はいずれも成形性が良好な結果となった。

【００４８】（実施例５）まず，表５に示す成分の冷延鋼板を準備し，これを連続式溶融亜鉛めっきラインの前処理炉にて焼鈍し，浴中のＡｌ量，Ｍｇ量，Ｓｉ量を変化させた４６０～６００℃の溶融亜鉛めっき浴で３秒溶融めっきを行った後，N_2ガスワイピングで表６～８に示すめっき付着量に調整し，ロール粗度，圧延圧下率を変化させたスキンパス圧延を行った。得られためっき鋼板のめっき層中組成と表面粗度を表６～８に示す。

【００４９】結晶配向性は，２５×２５ｍｍに切断したサンプルを$\theta-2\theta$法により測定し，ｄ＝２．４７３０Åに観察される（００２）面の積分強度I_{002}とｄ＝２．０９１０Åに観察される（１０１）面の積分強度I_{101}の比I_{002}/I_{101}を使用した。

【００５０】成形性はパンチ径５０ｍｍの金型を使用し，市販の防錆油を塗布後，円筒深絞り試験で評価した。ブランク径としわ押さえ荷重を変化させて評価し，ブランク径１１０ｍｍで絞り抜けたものを◎，ブランク径１０５ｍｍで絞り抜けたものを○，ブランク径１００ｍｍで絞り抜けたものを△，絞り抜けなかったものを×として評価した。

【００５１】結果を表６～８に示す。番号８１～９６は鋼板表面のＰＰＩが本発明の範囲外であるため成形性が不合格となった。これら以外はいずれも成形性が良好な結果となった。

【００５２】

【表１】

表1

試料番号	めっき中のAl%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	備考
1	0.02	60	1.0	220	110	○	×	比較例
2	0.05	60	1.0	220	110	○	○	本発明例
3	0.1	60	1.0	220	110	○	○	〃
4	0.5	60	1.0	220	110	○	○	〃
5	1	60	1.0	220	110	○	○	〃
6	5	60	1.0	220	110	○	○	〃
7	10	60	1.0	220	110	○	○	〃
8	12	60	1.0	220	110	○	×	比較例
9	0.4	30	1.0	220	110	○	○	本発明例
10	0.4	100	1.0	220	110	○	○	〃
11	0.4	150	1.0	220	110	○	○	〃
12	0.5	60	1.0	220	110	○	○	〃
13	0.5	60	0.4	220	110	×	○	比較例
14	0.5	60	0.5	220	110	△	○	本発明例
15	0.5	60	0.7	220	110	○	○	〃
16	0.5	60	1.2	220	110	○	○	〃
17	0.5	60	1.5	220	110	○	○	〃
18	0.5	60	1.0	130	65	×	○	比較例
19	0.5	60	1.0	150	80	△	○	本発明例
20	0.5	60	1.0	200	100	○	○	〃
21	0.5	60	1.0	250	120	○	○	〃
22	0.5	60	1.0	300	140	○	○	〃
23	0.5	60	1.0	220	90	×	○	比較例
24	0.5	60	1.0	220	100	△	○	本発明例

【0053】　　＊　＊【表2】

表2

試料番号	めっき中のAl%	めっき中のMg%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	耐食性	備考
1	0.02	0.5	60	1.0	220	110	○	×	○	比較例
2	0.05	0.5	60	1.0	220	110	○	○	〃	本発明例
3	0.1	0.5	60	1.0	220	110	○	○	〃	〃
4	0.5	0.5	60	1.0	220	110	○	○	〃	〃
5	1	0.5	60	1.0	220	110	○	○	〃	〃
6	5	0.5	60	1.0	220	110	○	○	〃	〃
7	10	0.5	60	1.0	220	110	○	○	〃	〃
8	12	0.5	60	1.0	220	110	○	×	〃	比較例
9	0.4	0.5	30	1.0	220	110	○	○	〃	本発明例
10	0.4	0.5	100	1.0	220	110	○	○	〃	〃
11	0.4	0.5	150	1.0	220	110	○	○	〃	〃
12	0.4	0.005	60	1.0	220	110	○	○	△	〃
13	0.4	0.01	60	1.0	220	110	○	○	○	〃
14	0.4	0.1	60	1.0	220	110	○	○	〃	〃
15	5	0.1	60	1.0	220	110	○	○	〃	〃
16	0.4	1	60	1.0	220	110	○	○	〃	〃
17	0.4	3	60	1.0	220	110	○	○	〃	〃
18	6	3	60	1.0	220	110	○	○	〃	〃
19	10	5	60	1.0	220	110	○	○	〃	〃
20	0.5	0.5	60	1.0	220	110	○	○	〃	〃
21	0.5	0.5	60	0.4	220	110	×	○	〃	比較例
22	0.5	0.5	60	0.5	220	110	△	○	〃	本発明例
23	0.5	0.5	60	0.7	220	110	○	○	〃	〃
24	0.5	0.5	60	1.2	220	110	○	○	〃	〃
25	0.5	0.5	60	1.5	220	110	○	○	〃	〃
26	0.5	0.5	60	1.0	130	65	×	○	〃	比較例
27	0.5	0.5	60	1.0	150	80	△	○	〃	本発明例
28	0.5	0.5	60	1.0	200	100	○	○	〃	〃
29	0.5	0.5	60	1.0	250	120	○	○	〃	〃
30	0.5	0.5	60	1.0	300	140	○	○	〃	〃
31	0.5	0.5	60	1.0	220	90	×	○	〃	比較例
32	0.5	0.5	60	1.0	220	100	△	○	〃	本発明例

【0054】　　※　※【表3】

表3

試料番号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	成形性	めっき密着性	備考
1	11	3	0.2	60	1.0	220	110	○	○	本発明例
2	11	3	0.2	30	1.0	220	110	○	○	〃
3	11	3	0.2	100	1.0	220	110	○	○	〃
4	11	3	0.2	150	1.0	220	110	○	○	〃
5	4	3	0.1	60	1.0	220	110	○	○	〃
6	20	3	0.3	60	1.0	220	110	○	○	〃
7	10	2	0.2	60	1.0	220	110	○	○	〃
8	10	10	0.8	60	1.0	220	110	○	○	〃
9	11	3	0.01	60	1.0	220	110	○	○	〃
10	20	3	2	60	1.0	220	110	○	○	〃
11	12	3	≦0.001	60	1.0	220	110	○	×	比較例
12	11	3	0.2	60	0.4	220	110	×	○	〃
13	11	3	0.2	60	0.5	220	110	△	○	本発明例
14	11	3	0.2	60	0.7	220	110	○	○	〃
15	11	3	0.2	60	1.2	220	110	○	○	〃
16	11	3	0.2	60	1.5	220	110	○	○	〃
17	11	3	0.2	60	1.0	130	65	×	○	比較例
18	11	3	0.2	60	1.0	160	80	△	○	本発明例
19	11	3	0.2	60	1.0	200	100	○	○	〃
20	11	3	0.2	60	1.0	250	120	○	○	〃
21	11	3	0.2	60	1.0	300	140	○	○	〃
22	11	3	0.2	60	1.0	220	80	×	○	比較例
23	11	3	0.2	60	1.0	220	100	△	○	本発明例

【0055】　　＊20＊【表4】

表4

試料番号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
1	0.5	-	-	60	1.0	220	110	1.5	○	本発明例
2	0.5	-	-	60	1.0	220	110	2	◎	〃
3	0.5	-	-	60	1.0	220	110	10	◎	〃
4	0.5	-	-	60	1.0	130	65	7	×	比較例
5	0.5	0.5	-	60	1.0	220	110	1.5	○	本発明例
6	0.5	0.5	-	60	1.0	220	110	2	◎	〃
7	0.5	0.5	-	60	1.0	220	110	10	◎	〃
8	0.5	0.5	-	60	1.0	130	66	7	×	比較例
9	6	0.1	-	60	1.0	220	110	1.5	○	本発明例
10	5	0.1	-	60	1.0	220	110	2	◎	〃
11	5	0.1	-	60	1.0	220	110	10	◎	〃
12	5	0.1	-	60	1.0	130	65	7	×	比較例
13	6	3	-	60	1.0	220	110	1.5	○	本発明例
14	6	3	-	60	1.0	220	110	2	◎	〃
15	6	3	-	60	1.0	220	110	10	◎	〃
16	6	3	-	60	1.0	130	66	7	×	比較例
17	11	3	0.2	60	1.0	220	110	1.5	○	本発明例
18	11	3	0.2	60	1.0	220	110	2	◎	〃
19	11	3	0.2	60	1.0	220	110	10	◎	〃
20	11	3	0.2	60	1.0	130	65	7	×	比較例

【0056】　　※40※【表5】

表5

記号	化学成分（質量%）										[%Ti]+0.52[%Nb]	4[%C]+3.4[%N]+1.5[%S]
	C	Si	Mn	P	S	Al	Ti	Nb	N	B		
A	0.0015	0.02	0.15	0.008	0.006	0.035	0.036	−	0.002	−	−	0.0216
B	0.0022	0.01	0.18	0.006	0.004	0.030	0.015	0.020	0.0014	−	0.0254	0.0186
C	0.0020	0.02	0.25	0.009	0.004	0.047	0.010	0.028	0.0021	−	0.0261	0.0211
D	0.0018	0.02	0.25	0.011	0.007	0.027	0.033	−	0.0022	0.0005	−	0.0252
E	0.0029	0.03	0.37	0.008	0.007	0.028	0.012	0.024	0.002	0.0008	0.0266	0.0258
F	0.0016	0.03	0.20	0.005	0.004	0.025	0.029	0.008	0.0018	−	0.0332	0.0189
G	0.0018	0.04	0.16	0.01	0.005	0.031	0.011	0.025	0.0017	−	0.0240	0.0205
H	0.0018	0.02	0.17	0.009	0.006	0.019	0.029	0.009	0.0018	0.0005	0.0337	0.0227
I	0.0016	0.008	0.20	0.003	0.003	0.033	0.024	−	0.0016	−	−	0.0169
J	0.0017	0.01	0.17	0.005	0.003	0.038	0.014	0.026	0.0016	−	0.0275	0.0167
K	0.0016	0.01	0.22	0.004	0.004	0.041	0.032	0.009	0.0017	−	0.0367	0.0182
L	0.0018	0.02	0.10	0.004	0.003	0.088	0.011	0.027	0.0014	0.0004	0.0250	0.0165
M	0.0017	0.01	0.20	0.003	0.003	0.037	0.038	−	0.0015	−	−	0.0164
N	0.0018	0.02	0.15	0.007	0.004	0.033	0.015	0.029	0.0014	−	0.0301	0.0180
O	0.0017	0.01	0.18	0.006	0.002	0.029	0.025	0.010	0.0016	0.0004	0.0302	0.0152
P	0.0330	0.02	0.44	0.021	0.010	0.036	0.014	−	0.0025	−	−	0.1555

【0057】　　＊　＊【表6】

表6

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
1	A	0.5	−	−	60	1.0	220	110	4	◎	本発明例
2	B	0.5	−	−	60	1.0	220	110	4	◎	〃
3	C	0.5	−	−	60	1.0	220	110	4	◎	〃
4	D	0.5	−	−	60	1.0	220	110	4	◎	〃
5	E	0.5	−	−	60	1.0	220	110	4	◎	〃
6	F	0.5	−	−	60	1.0	220	110	4	◎	〃
7	G	0.5	−	−	60	1.0	220	110	4	◎	〃
8	H	0.5	−	−	60	1.0	220	110	4	◎	〃
9	I	0.5	−	−	60	1.0	220	110	4	◎	〃
10	J	0.5	−	−	60	1.0	220	110	4	◎	〃
11	K	0.5	−	−	60	1.0	220	110	4	◎	〃
12	L	0.5	−	−	60	1.0	220	110	4	◎	〃
13	M	0.5	−	−	60	1.0	220	110	4	◎	〃
14	N	0.5	−	−	60	1.0	220	110	4	◎	〃
15	O	0.5	−	−	60	1.0	220	110	4	◎	〃
16	P	0.5	−	−	60	1.0	220	110	4	○	〃
17	A	0.5	0.5	−	60	1.0	220	110	4	◎	〃
18	B	0.5	0.5	−	60	1.0	220	110	4	◎	〃
19	C	0.5	0.5	−	60	1.0	220	110	4	◎	〃
20	D	0.5	0.5	−	60	1.0	220	110	4	◎	〃
21	E	0.5	0.5	−	60	1.0	220	110	4	◎	〃
22	F	0.5	0.5	−	60	1.0	220	110	4	◎	〃
23	G	0.5	0.5	−	60	1.0	220	110	4	◎	〃
24	H	0.5	0.5	−	60	1.0	220	110	4	◎	〃
25	I	0.5	0.5	−	60	1.0	220	110	4	◎	〃
26	J	0.5	0.5	−	60	1.0	220	110	4	◎	〃
27	K	0.5	0.5	−	60	1.0	220	110	4	◎	〃
28	L	0.5	0.5	−	60	1.0	220	110	4	◎	〃
29	M	0.5	0.5	−	60	1.0	220	110	4	◎	〃
30	N	0.5	0.5	−	60	1.0	220	110	4	◎	〃
31	O	0.5	0.5	−	60	1.0	220	110	4	◎	〃

【0058】　　※　※【表7】

表7

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
32	P	0.5	0.5	-	60	1.0	220	110	4	○	本発明例
33	A	5	0.1	-	60	1.0	220	110	4	◎	〃
34	B	5	0.1	-	60	1.0	220	110	4	◎	〃
35	C	5	0.1	-	60	1.0	220	110	4	◎	〃
36	D	5	0.1	-	60	1.0	220	110	4	◎	〃
37	E	5	0.1	-	60	1.0	220	110	4	◎	〃
38	F	5	0.1	-	60	1.0	220	110	4	◎	〃
39	G	5	0.1	-	60	1.0	220	110	4	◎	〃
40	H	5	0.1	-	60	1.0	220	110	4	◎	〃
41	I	5	0.1	-	60	1.0	220	110	4	◎	〃
42	J	5	0.1	-	60	1.0	220	110	4	◎	〃
43	K	5	0.1	-	60	1.0	220	110	4	◎	〃
44	L	5	0.1	-	60	1.0	220	110	4	◎	〃
45	M	5	0.1	-	60	1.0	220	110	4	◎	〃
46	N	5	0.1	-	60	1.0	220	110	4	◎	〃
47	O	5	0.1	-	60	1.0	220	110	4	◎	〃
48	P	5	0.1	-	60	1.0	220	110	4	○	〃
49	A	6	3	-	60	1.0	220	110	4	◎	〃
50	B	6	3	-	60	1.0	220	110	4	◎	〃
51	C	6	3	-	60	1.0	220	110	4	◎	〃
52	D	6	3	-	60	1.0	220	110	4	◎	〃
53	E	6	3	-	60	1.0	220	110	4	◎	〃
54	F	6	3	-	60	1.0	220	110	4	◎	〃
55	G	6	3	-	60	1.0	220	110	4	◎	〃
56	H	6	3	-	60	1.0	220	110	4	◎	〃
57	I	6	3	-	60	1.0	220	110	4	◎	〃
58	J	6	3	-	60	1.0	220	110	4	◎	〃
59	K	6	3	-	60	1.0	220	110	4	◎	〃
60	L	6	3	-	60	1.0	220	110	4	◎	〃
61	M	6	3	-	60	1.0	220	110	4	◎	〃
62	N	6	3	-	60	1.0	220	110	4	◎	〃
63	O	6	3	-	60	1.0	220	110	4	◎	〃
64	P	6	3	-	60	1.0	220	110	4	○	〃
65	A	11	3	0.2	60	1.0	220	110	3	◎	〃

【0059】　　＊　＊【表8】

表8

試料番号	鋼板記号	めっき中のAl%	めっき中のMg%	めっき中のSi%	めっき付着量 g/m²	Ra μm	PPI	Pc	配向性 I_{002}/I_{101}	成形性	備考
66	B	11	3	0.2	60	1.0	220	110	3	◎	本発明例
67	C	11	3	0.2	60	1.0	220	110	3	◎	〃
68	D	11	3	0.2	60	1.0	220	110	3	◎	〃
69	E	11	3	0.2	60	1.0	220	110	3	◎	〃
70	F	11	3	0.2	60	1.0	220	110	3	◎	〃
71	G	11	3	0.2	60	1.0	220	110	3	◎	〃
72	H	11	3	0.2	60	1.0	220	110	3	◎	〃
73	I	11	3	0.2	60	1.0	220	110	3	◎	〃
74	J	11	3	0.2	60	1.0	220	110	3	◎	〃
75	K	11	3	0.2	60	1.0	220	110	3	◎	〃
76	L	11	3	0.2	60	1.0	220	110	3	◎	〃
77	M	11	3	0.2	60	1.0	220	110	3	◎	〃
78	N	11	3	0.2	60	1.0	220	110	3	◎	〃
79	O	11	3	0.2	60	1.0	220	110	3	◎	〃
80	P	11	3	0.2	60	1.0	220	110	3	○	〃
81	A	0.5	-	-	60	1.0	130	65	2	△	比較例
82	B	0.5	-	-	60	1.0	130	65	2	△	〃
83	C	0.5	-	-	60	1.0	130	65	2	△	〃
84	D	0.5	-	-	60	1.0	130	65	2	△	〃
85	E	0.5	-	-	60	1.0	130	65	2	△	〃
86	F	0.5	-	-	60	1.0	130	65	2	△	〃
87	G	0.5	-	-	60	1.0	130	65	2	△	〃
88	H	0.5	-	-	60	1.0	130	65	2	△	〃
89	I	0.5	-	-	60	1.0	130	65	2	△	〃
90	J	0.5	-	-	60	1.0	130	65	2	△	〃
91	K	0.5	-	-	60	1.0	130	65	2	△	〃
92	L	0.5	-	-	60	1.0	130	65	2	△	〃
93	M	0.5	-	-	60	1.0	130	65	2	△	〃
94	N	0.5	-	-	60	1.0	130	65	2	△	〃
95	O	0.5	-	-	60	1.0	130	65	2	△	〃
96	P	0.5	-	-	60	1.0	130	65	2	×	〃

【0060】

【発明の効果】以上、述べてきたように、本発明によれば酸化物を生成させたり、被膜を形成させたりする設備※を必要とせずに、成形性に優れた溶融亜鉛めっき鋼板を製造することができ、産業上極めて大きな効果を奏するものである。

フロントページの続き

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